Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, D.C. 20554

In the Matter of:	)	
	)	**ET Docket No. 02-135**
Spectrum Policy Task Force Report	)	

To: The Commission

COMMENTS OF WEBLINK WIRELESS, INC.

WebLink Wireless, Inc.("WebLink"), by its attorneys and pursuant to Federal Communications Commission ("FCC" or "Commission") Public Notice, FCC 02-322 dated November 25, 2002 as modified by DA 02-3400 dated December 11, 2002, hereby submits its Comments in connection with the Spectrum Policy Task Force Report ("Report".) The Report was released by the Commission on November 15, 2002.

In support of its Comments, the following is respectfully shown.

I. STATEMENT OF INTEREST

WebLink is a nationwide messaging carrier located in Dallas, Texas. It is a leader in the wireless data industry, providing wireless email, wireless messaging, information on demand and traditional paging services throughout the United States. WebLink's FCC licensed subsidiaries hold 929 MHz exclusive paging and Narrowband Personal Communications Service ("NPCS") licenses. Because the recommendations in the Report could significantly impact WebLink's use of its spectrum, WebLink has standing as a party in interest in this proceeding.

II. INTRODUCTION

The Spectrum Policy Task Force was established in June 2002 to provide specific recommendations to the Commission to change the "command and control"[1] approach to spectrum policy into a market-oriented approach which would, ideally, offer greater regulatory certainty with less regulatory intervention; and to assist the Commission in addressing spectrum issues such as interference protection, spectral efficiency, effective public safety communications and international spectrum policies. A major Task Force recommendation was the proposed evolution from the "command and control" to "exclusive use" and "commons" spectrum rights models, which would allow lesser or greater degrees of spectrum sharing, respectively.

While WebLink commends the Commission for its review of spectrum policy, it has many concerns with the Report. In particular, WebLink is opposed to any shared access in exclusive spectrum, specifically with respect to paging and messaging.

III. DISCUSSION

A. More Industry Input Is Needed

WebLink submits that the Report is only a first step toward the reform of spectrum management. While it does raise significant issues and offers some possible approaches to accommodate new technological advancements, the Report should be viewed as only the beginning of the process. Input is needed from all industry groups with their particular requirements and concerns relating to the design and operation of networks in the provision of interference-free service to end-users. To that end, efforts should be made to establish a baseline that could include a research project on spectrum occupancy; control groups; and frequency

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1 Under this model, the Commission describes in detail how the spectrum may be used, the technical characteristics of usage, construction schedules and other factors.

testing to insure that end-users are protected. WebLink looks forward to participating in such a process and would be pleased to work with the FCC staff to demonstrate the actual operation of a narrowband wireless network.

However, without adequate input from the actual spectrum licensees, the Report cannot at this point be used as a platform for new spectrum management. WebLink agrees with many earlier commenters in this proceeding that spectrum management must be based on a long term plan, with a cost-benefit analysis as part of each allocation decision. The current approach to spectrum allocation has often been reactive and on an ad hoc basis. However, spectrum dependent businesses, such as WebLink, find it difficult to make long term plans with ad hoc policies. An important goal of a spectrum management plan is to provide more predictability and policy guidance to the allocation process.

B. The Task Force Has Made Assumptions Inappropriate to Paging Frequencies

WebLink submits that the Report has made certain assumptions in the Task Force process that have not been tested and are not supported in WebLink's operating environment. WebLink's engineering staff memorandum, attached as Exhibit 1, provides insight into that environment.

1. The Task Force assumes that a blanket approach should be taken for an expansive group of frequencies. The Report envisions an evolution from the traditional FCC "command and control" spectrum model to a “commons” model that would allow an unlimited number of unlicensed users to share spectrum and an “exclusive use” model that would be subject to underlays or spectrum easements by unlicensed operators.

WebLink asserts that there cannot be such a sweeping approach to spectrum policy. The spectrum users under the FCC's jurisdiction are a widely diverse group. These users need a coherent approach to their unique portions of the spectrum in order to operate successfully in the marketplace. Appropriate interference protection and other restrictions are also necessary to provide licensees with the certainty they need to develop long-term business plans. Particular bands, such as paging bands, are most suitable for certain services. For example, because of their narrow channels and restricted bandwidth, paging networks are very susceptible to interference, but do not have a great deal of capacity to recognize it. Because of those characteristics, the exclusive paging bands should not be subject to any sharing.

2. As Exhibit 1 points out, the Task Force uses a model that assumes that the spectrum "box" is only partially filled; that a partially filled box is a poor model of resource allocation; and that it would be desirable to fill the box.[2] This assumption is inaccurate with respect to paging carriers. The emphasis should be on the end-to-end flow of application-oriented information and the various ongoing degradation events encountered. The Report's "proxy" for channel efficiency does not address the impact of degradations upon the whole process of end-to-end wireless messaging communications.

3. The Task Force assumes a voice-implicit model for interference protection. This is inaccurate in WebLink's case, with its provision of wireless data messaging. As Exhibit 1 asserts, in the case of NPCS, the measures of channel efficiency and message latency would be much more compromised than a wireless phone service.[3] The voice communication will first, smooth over lost or degraded frames; second, present the communicating parties with noise and drop-outs; third, it will attempt to hand-over to a better channel; and finally, it will drop the call. On the other hand, ReFLEX™ NPCS will continue to resend store-and-forward traffic for 36 hours on the WebLink network. If sufficient degradations are encountered, the intended recipient may never receive the message and would not know that it had been sent. Further, as pointed out

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2 Exhibit 1 at 1.

3 Exhibit 1 at 2-3.

in Exhibit l, wireless data communications is “bursty” and channel degradations are likewise “bursty”.[4] Because of this, the “spectrum box” is not uniformly filled. "These bursts of channel degradations are analogous to tears or inclusions in the fabric of the channel...and they are in positions ‘in the box’ at which no signal energy can effectively be placed. As such, they reduce the usable volume of the box." In addition, channel coding and retransmission must work around this information in the box, which further reduces the volume of it. In sum, there is not enough room in the box for underlaying unlicensed users.

4. As stated in Exhibit 1, the Task Force appears to assume that background interference may be characterized in terms of a “temperature.”[5] However, this concept comes from thermodynamics and pertains only to systems that have reached a form of steady-state in which energy is equally distributed. In contrast, most communications networks do not operate under steady-state conditions, but are subject to rather extreme fluctuations in volume. Thus, "[i]f 'interference temperature' is deemed to measure only the average background level, then it will certainly fail to capture the property of extreme fluctuations in level." In addition, Exhibit 1 summarizes three different service scenarios and the effect of increased interference temperature, and concludes: “the proposed proxy for spectrum efficiency completely misses the essential fact that the increase of ‘interference temperature’ will have significantly different impacts on service efficiency subject to channel constraints in many services.”[6]

5. The Task Force assumes that such technical equipment as frequency agile radios or smart receivers are or could be readily available. However, they are not available in the paging industry and there would be a substantial delay in the production of such equipment.

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4 Exhibit l at 3.

5 Exhibit 1 at 4.

Further, paging carriers such as WebLink operate a low cost service. New frequency agile equipment would raise the cost of WebLink's operation and ultimately, could force customers to abandon the service. Since the paging customer base has eroded over the past several years, such a regulatory requirement would add to the outflow of the paging consumers and further threaten the financial viability of the paging industry.

C. There Should Be No Exclusive Paging Frequency Sharing

WebLink has obtained six NPCS auction licenses for which it paid over $130,000,000.00. Additionally, it has built a multimillion dollar paging and wireless messaging network; and it pays monthly site leases for its approximately 2000 sites throughout the nation. It bid on the NPCS licenses based on the technical and service rules in place and expected to have a stable operating environment going forward. Those expectations were the basis for the system design and engineering for the deployment of an efficient system. It is an economic necessity that WebLink be assured that it will be protected from significant and costly changes to its network caused by regulatory action in the future. Because the Report emphasizes the importance of the market in spectrum management, WebLink requests that the Commission consider the adverse consequences to the paging market from any wholesale change to the paging frequency bands.

WebLink must also be assured that it will be provided protection from interference. Presently, interference is a real, almost constant issue for the paging industry, even without frequency sharing on its licensed frequencies. As discussed in Exhibit 1, WebLink cannot be assured of interference protection under the Report's scenario: "...the real problems arise when interferers yield non-linear effects such as inter-modulation distortion, receiver self-quieting,

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6 Exhibit 1 at 6.

phase steps or FM click noise." [7] That type of interference can come from components of the receiver; but also, high-power combiners can produce inter-modulation, harmonics and FM-AM conversion.

As discussed above and in Exhibit 1, WebLink's interference concerns focus on the Task Force's concept of interference temperature, which would measure the RF noise power available at receivers in an effort to manage interference. Taking this temperature would, according to the Report, be the basis of determining the maximum permissible levels of interference to increase access to spectrum by unlicensed users. Integral to this approach is the measurement of RF noise floors. The problem is that the measurement would not be constant. For example, WebLink poses the following scenario of a rain-affected satellite transmission in conjunction with unlicensed users:

> Now imagine that during an extreme rain fade, a background user were to begin to transmit in the vicinity of the remaining active sites in the region of the rain cell. The motivation to increase transmissions may well be the news of the heavy storm itself. Perhaps the users are Instant Messaging about traffic back-ups due to the storm. Perhaps it is public safety responders dispatching emergency teams to accidents caused by the rain. The exact details are not necessary; it is merely plausible to imagine that background interference would increase in such an event. Assume then that this increase in noise level effectively removes the last remaining sites from service by increasing their receiver noise floors above the operating limit. Now, communications to and from users of our network in that vicinity are blocked by the combination of the rain fade and increased co-channel interference. As a result, messages to our customers would be held in queue for repeat later, and messages from the mobile units would fail. Our customers would be "stranded" until the fade cleared, and while our network struggled to clear itself of a backlog of queued traffic. If one were to return to the exact location later, and measure the operational conditions of our network and the interfering one, no problem would be found. [8]

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7 Exhibit 1 at 4.

8 Exhibit 1 at 5-6.

WebLink agrees that the noise floor is a critical factor. Operations in a given service are premised on the existing noise floor. Systems have been designed to provide reliable service over a given area and with a particular quality of service based on the expected noise floor. However, the Task Force did not adequately take into account how the existing paging service providers and/or users will be affected by even a small increase in the noise floor due to a new spectrum assignment. An increase by even a few dBs may impact WebLink's existing licensed system and its customers in a number of ways, with respect to coverage, system capacity and reliability of data throughput.

The existing interference management methodology for paging frequencies has been tested and refined through a long process. WebLink believes that this methodology is adequately providing interference protection to operators and should be kept intact. Any change in methodology to accommodate unlicensed users would raise the noise floor level and require a paging carrier to change its system or mitigate interference caused by such users in its frequency band. RF monitoring equipment would have to be installed at WebLink’s sites. However, it is almost impossible to locate interfering unlicensed devices because they have no IDs and are not confined to a fixed location. Thus, it may not be possible for the incumbent to mitigate interference without the cost of reengineering. Allowing unlicensed users in the paging frequency bands could also limit technical and service options and definitely would limit flexibility. The Task Force’s proposed approach to interference protection would drastically change the terms of the WebLink licenses. The Commission should not allow unlicensed users on the exclusive paging frequencies.

D. Separate Bands for Unlicensed Services

Since any such changes would affect the fundamental right of incumbents, the Commission should allocate separate bands for unlicensed services on a going forward basis in bands above 50 GHz. As the Report states, in these bands:

> The propagation characteristics of spectrum preclude many of the applications that are possible in lower bands…and instead favor short-distance line-of-sight operation using narrow transmission beams. <u>Thus, these bands are well-suited to accommodate multiple devices operating within a small area without interference.</u>[9]

However, should the Commission allow frequency sharing in existing encumbered frequency bands, it must then provide the necessary enforcement with regard to interference problems. The FCC must have sufficient resources in the field to assist incumbents in locating and eliminating interference sources. The FCC must also impose penalties on those entities who cause intentional interference.

E. Public Interest

The Commission is charged with the regulation of communication by wire and radio in the public interest as well as the protection to exclusive licensees from harmful interference. As Exhibit 1 explains, additional users of the frequency will limit the network system's ability to overcome the roadblocks in the end to end communications provided to the consumer. Thus, the Commission should not allow existing exclusive licensees to have their signals degraded by unlicensed spectrum users at the expense of the public.

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[9] Report at 39. Emphasis added.

CONCLUSION

WHEREFORE, the foregoing having been duly considered, WebLink Wireless, Inc. respectfully requests that the Commission consider these comments and not permit unlicensed users in the exclusive paging frequency bands.

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Respectfully submitted,
WEBLINK WIRELESS, INC.

Audrey P. Rasmussen

David L. Hill
Audrey P. Rasmussen
ITS ATTORNEYS

HALL, ESTILL, HARDWICK, GABLE, GOLDEN & NELSON, P.C.
1120 20th Street, N.W.
Suite 700, North Building
Washington, D.C. 20036-3406
Telephone (202) 973-1200
Facsimile (202) 973-1212

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EXHIBIT 1

WebLink Wireless, Inc.

3333 Lee Parkway
Suite 100
Dallas, TX 75219 k

Phone: 214-765-3470
Fax: 214-765-4219
Email: allan.angus@weblinkwireless.com
Website: www.weblinkwireless.com

MEMORANDUM

From: Allan Angus, PE, MSc
Selwyn Hill, PE, MS Eng

Date: 01/28/03

Re: FCC Spectrum Task Force Report

Here are our comments on the FCC Task Force Report ("TF"). They also include comments on some of the material in the underlying Working Group Reports ("WG"), especially that of the Spectrum Efficiency Working Group. They are collected under the heads that follow.

Measures of Efficiency

Much of the impetus for the report is an assumption that the present resource allocation yield inefficient use of spectrum. Four dimensions of usage are identified: bandwidth (Hz), space (m^2), time (s), and power (W). One relatively simple view of the situation would be to consider the resource under the FCC's mandate as a "box" with a volume equal to the product of several GHz times the area of the US times 3600 s in every hour times some acceptable level of power. The report (and the related Spectrum Efficiency Working Group Report) appears to suggest that

1. this box is only very partially filled;
2. that the reason for this is a poor model of resource allocation on the part of the FCC;
3. that it would be desirable to fill the box more than it is at present.

The proposed dimensions are not completely without merit; they happen to be components of Shannon's classic equation[1] for the efficiency of a communications channel, with one notable omission; noise, or more accurately, signal to noise ratio, and with one notable addition, area.

Shannon considered a point-to-point channel, and so the matter of geographic coverage was not a component part of his analysis. Nonetheless, he proceeded in a manner quite easy to understand, if somewhat abstract. As the report envisions, he supposed that a communications channel could be characterized as a volume in an abstract space with the dimensions of information, bandwidth times time. He established a metric on the space, or a measure of distance between points, and he considered how densely the space could be filled with signals in the presence of noise.

Shannon's working assumption, equivalent to that of the TF, is that the available volume for messages scales as the dimensions of the box, or that the box could be densely packed with information. Said another way, he worked out how big a bit is and the volume occupied by noise.

1 Shannon, C.E., A Mathematical Theory of Communication, The Bell System Technical Journal, Vol. 27, pp. 379-423, 623-656 (1948). Shannon's Theorem, put forth by Claude Elwood Shannon in 1948 gives an upper-bound on the Capacity of a communications link (in Bits/Second), as a function of the link Bandwidth and the SNR (Signal-To-Noise Ratio).

The implicit measure of efficiency

To support the notion that spectrum is poorly used, the report presents graphs of the power density at fixed locations in selected markets as functions of time. To the casual observer, the charts appear to show "holes" in the utilization of the resource. Implicitly, the authors of the report appear to be arguing that the situation would be superior if these charts showed uniform power densities across the spectral bands being studied.

To a more experienced eye, the patterns displayed are reminiscent of those analyzed and popularized through the work of Benoit Mandelbrot; that is, they are statistically self-similar fractals (or multi-fractals). [2] A more appropriate working analogy might be measures of the porosity or capacity of reservoir rocks in the oil and gas industry. Nevertheless, this is a digression; one to which we shall return later.
We must challenge the (failed) notion that a suitable measure of communications efficiency can be established by "filling the box" uniformly with signal power or energy. This is not even a remotely adequate proxy for communications effectiveness.

End-to-End communications efficiency

The fundamental issue is that this proposed proxy focuses on upon the physical layer of the air interface without considering the end-to-end flow of application-oriented information. Typically, applications are deployed using appropriate link, network, and transport layer functions that account for channel degradations that may occur on the link. To offer but three examples of the very different responses of end-to-end communications paths in a degraded wireless environment, consider PSTN-interconnected digital voice (as in cellular), Internet-connected TCP/IP services (as in IEEE 802.11), and assured messaging (as in ReFLEX™ NPCS).

In such cases, the fundamental concept of channel efficiency is based upon throughput relative either to offered load or to raw channel capacity. Offered load may exceed raw channel capacity; and in such cases, offered load may be blocked or queued. Throughput may increase with offered load; or, as in simple Aloha, may collapse catastrophically even as raw channel rate increases. In short, the relationships between these parameters are rarely linear in practical systems.

Throughput to offered load under channel degradations

Under increasingly degraded channel conditions, the digital voice circuit will first, smooth over lost or degraded frames; second, present the communicating parties with non-linear voice artifacts and drop-outs; third, attempt to hand-over to a better channel; and finally, drop the call. Outside of some out-of-band administrative traffic to support handover, the communications throughput relative to offered load will not change.

Under similar circumstances, the TCP/IP oriented connection will first, retry lost packets; second, adapt congestion buffers; third, reset the transport layer; and fourth, drop the connection. At various stages of this process, significant numbers of repeated packets will occur, representing more raw air interface traffic that reduces throughput relative to offered load.
In the case of degraded channels in the NPCS environment, the traffic will first, be retried to some threshold number of attempts; second, the subscriber will be placed in a search queue and subject to a timed repeat of search messages; third, when the link to the subscriber is recovered, the unacknowledged traffic will be resent. This process will repeat until such time as the message is ultimately received without error. For practical purposes, the "connection" for message delivery is persistent for several days.

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[2] Mandelbrot, B.B., The Fractal Geometry of Nature (1983). Benoit Mandelbrot was largely responsible for the present interest in fractal geometry. He showed how fractals can occur in many different places in both mathematics and elsewhere in nature.

Efficiency as lost traffic (throughput/offered load)

In each of these cases, the intended communications service operates against a variety of channel degradations including noise, interference, inter-modulation distortion, Rayleigh or Ricean fading,[3] shadowing, channel excess delay spread yielding time dispersion of signal energy, random Doppler yielding frequency dispersion of signal energy, and so on. The Shannon theory does not begin to deal with the capacity of channels of this sort, in which signal energy "leaks" from the channel or is shifted into other parts of the "box" creating self-interference.

Likewise, the TF Report's proxy for channel efficiency does not address the impact of such degradations upon end-to-end communications and the potential protocol catastrophes that can result. To return to the three examples, increasing a background "interference temperature" would not likely reduce channel efficiency expressed as the ratio of throughput to offered load until the call was dropped. Depending upon the subsequent behavior of the communicating parties, re-established calls may not even be recognized as variations in the volume of energy "in the box."

In contrast, in the TCP/IP case, as channel degradations were increased by increasing an interference temperature, the measure of efficiency as the ratio of intended traffic throughput to offered load would show sharp and sudden increases. As well, another Quality of Service metric, latency, would be compromised as the number of retries to ensure packet delivery increased. Finally, the reliability of communications, expressed as the fraction of dropped TCP connections, would be increasingly degraded.

Likewise, in the assured-delivery NPCS case, the same measures of channel efficiency (as the ratio of throughput to offered load) and message latency would be even more compromised than in the TCP case. The essential reason for this is that TCP automatically clears connections that attempt to operate over severely compromised links, while ReFLEX™ NPCS will continue to resend store-and-forward traffic until a positive acknowledgement of receipt is obtained.

Quality of Service constrained Efficiency

These three cases are representative of the architectural issues the present themselves to the designers of wireless communications networks. The functions that manage the delivery of end-to-end Quality of Service metrics are embodied in the network elements that manage access to the air interface and that schedule the flow of user traffic across it. The TF Report and the related Report of the Spectrum Efficiency Working Group discuss the bursty nature of the arrival of offered load on public safety systems. These high peak-to-mean ratios are not unique to public safety networks. Rather, they are typical of a wide variety of digital communications networks. Likewise, radio channel degradations (fades, noise, and so on) are similarly bursty in their arrivals whether viewed in the dimensions of time, space, frequency, or received signal energy.

This implies that the paradigmatic case for wireless data communications is "bursty" in all of the dimensions of offered load (space and time), and that channel degradations are likewise "bursty" in the dimensions of received signal energy, noise and interference, frequency and time dispersion. These characteristics, in and of themselves, defeat the Shannon-style analysis of radio channel capacity in terms of uniformly "filling the box."

These bursts of channel degradations are analogous to tears or inclusions in the fabric of the channel. To return to the previous analogy of oil and gas reservoirs, they are like the stones in a sandy conglomerate rock that reduce the flow of oil under pressure. They are the potholes on the information highway. They are positions "in the box" at which no signal energy can effectively be placed. As such, they reduce the usable volume of the box. Since their locations cannot be detected ahead of time, digital radio protocols

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[3] See Microwave Mobile Communications, IEEE Press, NY (Jakes, W.C. ed., 1974).

are designed to work around their unavoidable presence. While they are random, they are "self-similar" in the sense that their patterns repeat at both the largest and the smallest scales of time, power, frequency, and space. [Again, see Mandelbrot and his fractals.] The dominant work-arounds are channel coding and retransmission. Both of these methods have the property of placing the same information at multiple locations "in the box" in order to avoid the potholes on the information highway.

Channel coding consumes extra bandwidth, thereby reducing the ratio of user data throughput to raw transmission rate. In many applications, the alternative of retransmitting information is unacceptable. On the other hand, protocols that detect information loss and then retransmit it are subject to potential catastrophes in the sense that they need to know "when to quit." Those that are not so intelligent, like simple Aloha, can easily fill the channel with retransmitted signal energy while achieving zero information throughput. The "box" is filled with signal energy, but no new information is sent. This is very important to note, since it implies (to us at any rate) that merely measuring spectrum occupancy is not a good proxy for information flow. To the contrary, the hypothesis that spectrum occupancy would be a useful proxy for useful information flow in all wireless bands from VLF to UHF seems to be an interesting research question that might well be posed to appropriate R&D agencies and universities before being made a matter of public policy.

The typical wireless communication network is designed to satisfy certain Quality of Service metrics that are desirable for the intended service subject to the constraints of bursty arrivals of offered load and channel degradations. The most telling aspects of the corresponding protocols (at all layers) are the design trade-offs between channel coding for error correction and detection versus data retransmission. In the case of a real-time streaming service like digital voice, there is no merit in data frame retransmission; it would merely add bizarre and random delays to short bursts of voice. In this application, errors must be dealt with before the fact with sufficient error coding. In a store-and-forward service like NPCS assured messaging, error coding can be slight and easily compensated for with retransmissions. This service employs simulcasting and reverse channel diversity to mitigate channel degradations. Finally, in a low latency, connection-oriented TCP/IP service, error coding (and hence useable bandwidth) can be adaptive, as is done in IEEE 802.11.

Non-linear effects

The Shannon approach to channel capacity, and that assumed in the report, is based on linear additive systems theory. For example, the report assumes that the impact of background interference will be linearly additive to an existing communication system in the sense that a small interference will yield a small perturbation in the channel. The truth of the matter is that such linear cases are rarely a problem. Rather, the real problems arise when interferers yield non-linear effects such as inter-modulation distortion, receiver self-quieting, phase steps or FM click noise. In practice, such non-linear effects are generated not in the radio channel but in the material components of the receiver. This is not to say that transmission systems are immune; high-power combiners can produce inter-modulation, harmonics, FM-AM conversion, and so on. In short, whenever the linear operating range of an element is exceeded, such effects may occur; and the linear range of a component may be measured in mV or kV depending on where it is used in the communications pathway. Other non-linear combining effects take place because of the dynamic functions of higher-level protocols, as they act to maintain channel throughput or QoS metrics.

Intermittency

The reports also appear to assume that background interference may be characterized in terms of a "temperature." This concept comes from equilibrium thermodynamics and pertains only to systems that have reached a form of steady-state in which energy is equally distributed into many available states. In contrast, most communications networks do not operate under steady-state conditions, but are subject to rather extreme fluctuations in offered load. The reports take care to note this effect in the special case of public safety radio in which peak-to-mean ratios of offered load are 4:1 or higher. We reply that such conditions are not limited to the public safety but are typical of a wide variety of networks include LANs, the Internet, and so on.

It is therefore difficult to imagine that if background interference were to be the result of operations of, for example, Wi-Fi like radio networks that inter-operate with LANs or the Internet, their spectral occupancy characteristics would not show the same intermittency properties that characterize the offered load.

If "interference temperature" is deemed to measure only the average background level, then it will certainly fail to capture the property of extreme fluctuations in level.

Another matter goes to the correlations between such intermittent bursts of traffic coming from multiple sources. One would expect that in such cases as extremely noteworthy news events, the concurrent usage of public safety networks, cellular telephones, paging networks, Wireless LANs, and so on, would all simultaneously increase as the news, responses to it, and discussions concerning it, proceeded.

A simple example from our sector

Such news does not have to be earth-shaking. Our network uses TCP/IP VSAT technology to deliver paging and 2way messaging traffic to and from about 2000 base station sites around the US interconnecting to a central hub in Atlanta via a set of geo-synchronous satellites. A common channel degradation on the satellite link is a rain fade over a market due to dispersion and scattering losses from the volume of water in the atmosphere over the VSAT dishes. While the link has a certain margin to such fades, and more gain may be adaptively added, there are conditions under which the transmission and reception of information from individual sites is compromised.

Our network compensates for such conditions by employing forward channel simulcasting and reverse channel "macro-diversity." On the forward channel, many transmitters synchronously send the same modulation. On the reverse channel, many receivers have the opportunity to detect mobile device transmission. A round average for a typical urban market may be 4 to 5 receiver sites detecting any given device transmission. In the special case of a severe rain fade, this number may drop to 1 or 2 in the vicinity of the densest part of a rain cell.

We take care to measure the background noise characteristics at all of our sites. Site noise figures can range from 4 dB to over 20 to 30 dB. A broad average may be around 8 dB above the expected thermal noise floor. While we attempt to avoid the more extremely noisy sites, there are situations in which the availability of leases at economic prices in certain locations limits our choices. In such cases, we utilize noise-mitigating technologies to the extent necessary; for example, dual-polarized antennas, gain-steered antennas, pre-filtering, and so on. Since these measures further increase site capital or operating costs or both, they are used only in those cases where they are deemed necessary. There is a direct relationship between these increased costs and the noise immunity ratios of our receiver locations.

Now imagine that during an extreme rain fade, a background user were to begin to transmit in the vicinity of the remaining active sites in the region of the rain cell. The motivation to increase transmissions may well be the news of the heavy storm itself. Perhaps the users are Instant Messaging about traffic back-ups due to the storm. Perhaps it is public safety responders dispatching emergency teams to accidents caused by the rain. The exact details are not necessary; it is merely plausible to imagine that background interference would increase in such an event. Assume then that this increase in noise level effectively removes the last remaining sites from service by increasing their receiver noise floors above the operating limit.

Now, communication to and from users of our network in that vicinity are blocked by the combination of the rain fade and increased co-channel interference. As a result, messages to our customers would be held in queue for repeat later, and messages from the mobile units would fail. Our customers would be "stranded" until the fade cleared, and while our network struggled to clear itself of a backlog of queued traffic. If one were to return to the exact location later, and measure the operational conditions of our network and the interfering one, no problem would be found.

Summary of Efficiency Considerations

To summarize, the proposed proxy for spectrum efficiency completely misses the essential fact that the increase of "interference temperature" will have significantly different impacts on service efficiency subject to channel constraints in many services, as exemplified by our three cases. Network designers typically attempt to solve a constrained optimization problem in which the goal is to maximize the ratio of throughput to offered load subject to the requirement to satisfy Quality of Service ("QoS") metrics that are unique to different services.

Many such wireless networks operate to the intended QoS metrics under a wide range of offered loads and channel degradations. When stressed past their design tolerances, they rapidly degrade in terms of their throughput efficiency. The Commission must consider that it unlikely that a purely spectrum-oriented view of service efficiency will increase the satisfaction of customers of wireless services.

Baselining

The putative argument of the TF Report is, again, that spectral efficiency is presently poor. While the Report begins with some objective measures of efficiency, they are quickly set aside as being overly complex. The result is that the proposed policy directions will be absent any objective baseline of present efficiency against which the impacts of the proposed policy can be assessed if and when it were to be put into force.

Absent a well-defined initial measure and stated goals, it will be extremely difficult to assess the impact of the proposal. This contrasts such other public policy goals such as the reduction of green-house gasses or improvements in public education or the like. Since the only metrics presented in the TF Report appear to be the charts showing the "bursty" characteristics of present wireless applications, one expects that the FCC would ultimately fall back to the same ad hoc measure later; namely, that the policy will have been effective if the signal power density in test markets becomes increasingly uniform over time. As discussed earlier, this model fails to account for the real communications problem owned simultaneously by network operators and users alike.

A Research Project

To return to the previous observation that the question of the relationship between spectrum occupancy and information flow is an interesting research project. We propose that if the Commission is concerned about the efficient use of the public spectrum resource, then it fund serious research into the matter of capacity metrics in the wireless services. The research goal would be to assess whether or not accessible measures of spectrum occupancy in the proposed dimensions of power, frequency, space, and time do correlate well with usable information throughput in a variety of services. If the correlations are conditional, to discover what those may be. Finally, the end goal would be to return to the public forum with recommendations on suitable objective metrics for the efficient use of the public spectrum resource that the FCC may go forward with.

A proposed baseline

In the meanwhile, we propose instead that a more suitable pragmatic baseline would be the present busy-hour efficiency of incumbent operators in terms of the average ratio of throughput to offered load during peak periods of traffic. Should the execution of the FCC's proposed policy incentive yield significant reductions in this metric, we would expect that it would correspond to a chain of dissatisfied customers, economic losses to service providers, and even more potential failures in the wireless communications sector than are already envisaged due to current economic conditions.